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Towards Efficient Water Bottling Operations: A Continuous Improvement Analysis and Deep Learning-Driven Master Production Scheduler

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Abstract– **We present a comprehensive solution aimed at enhancing water bottling operations by addressing production planning inefficiencies and order non-compliance, the MPS integrates forecast modelling, inventory control, and production management to streamline operations. By mitigating rushed production and order shortages, the MPS implementation significantly reduced penalties (41.48%) and improved resource utilization, including an 80.22% decrease in overtime usage. Incorporating LSTM models for demand projection enhances accuracy by accommodating seasonality's and non-linear trends effectively. Economic indicators validate the technical and economic viability of the proposed solutions, yielding an average monthly profit increase of $20.64K$ PEN. Integration with the company's ERP system automates processes, while a modifiable forecast horizon and data-driven insights enable adaptive forecasting. Continuous improvement remains central, ensuring ongoing optimization of operational efficiency and predictive accuracy to meet evolving business needs.**

Keywords— **Master Production Schedule, Deep Learning, Long Short Term Memory, Forecasting, Continuous Improvement**

I. INTRODUCTION

The bottled water market in Peru has exhibited substantial growth, particularly in sales to supermarkets, wineries, markets, and convenience stores, reflecting a 3.9% increase in this sector by the end of 2017. The turnover of major supermarket chains also saw a significant increase, registering a 5.3% growth compared to the previous year, reaching 14 million PEN. This growth underscores the escalating demand for bottled water within the country []. The company under investigation specializes in the production of branded bottled water and provides manufacturing services (contract manufacturer) for major sellers in the country, including prominent supermarket chains. Since 2017, the company has demonstrated substantial growth and currently commands a considerable portion of the supermarket market, with an overall market share of 10.4%, competing alongside major bottlers.

The product portfolio composition as of the first quarter of 2019 includes various product lines, with sales experiencing an 8% growth compared to the previous quarter. However, heightened demand for certain product lines has led to challenges in demand forecasting and warehouse management, resulting in issues such as incomplete order fulfillment, penalties for delayed delivery, stock shortages, and compromised product quality. Critical operational challenges predominantly manifest in the production and logistics domains. Presently, demand calculation methodologies fail to accurately reflect actual demand, resulting in production being solely order-driven without adequate demand forecasting or inventory management. Consequently, the company faces difficulties in meeting orders, compounded by recent sales escalations. During the last quarter of 2019, the company required a substantial volume of treated water across various presentations. Moreover, significant wastage occurs during different production phases, with efficiency rates in treated water usage and average loss during bottle filling, sealing, and packaging stages noted. The over-reliance on overtime and equipment usage until failure further compounds operational inefficiencies.

To mitigate these challenges, the company proposes a comprehensive re-engineering effort encompassing planning, inventory management, and workflow optimization as in Gil et al. (2018). The implementation of a Master Production Schedule (MPS) based on demand analysis, supported by data analysis tools to develop a Deep Learning (DL) Long Short-Term Memory (LTSM) model, is envisaged. This approach aims to enhance production planning, establish an effective inventory system, and augment productivity through Takt Time. One similar example of the methodology is in Pocorey et al. (2017) It is defined by the available production time divided by the customer demand. Where the available production time represents the total time available for production, typically calculated per shift and the customer demand shows the rate at which customers require products to be delivered. This concept helps in synchronizing the production process with customer demand, ensuring that production rates match the rate at which products are needed by customers. It serves as a guideline for setting the pace of production, enabling efficient use of resources, and minimizing waste. The analysis and validation of the proposed and implemented techniques will take place following a joint utilization of these concepts. The major contributions of our work can be outlined as follows:

- We establish an MPS implementation framework for production planning in the context of a bottling company.
- We examine Takt Time calculation, integrating safety stock and reorder points to optimize inventory management through continuous improvement techniques.
- We utilize data analysis tools to create a neural network- powered LSTM model, aiming to enhance the current forecasting significantly. We compare its performance against other established models to benchmark its performance.

The structure of the remainder of this article is as follows: Section II introduces the case study while defining the different parameters and business workflow. This is followed by the implementation and development of the measures covered in Section III and Section IV. Section V explores the economic impact of the proposed strategy. Finally, Section VI expands on further discussion.

II. PROBLEM DEFINITION

An in-depth analysis of the production processes captures the underlying business model and pinpoints activities that fail to add value. The identification will reveal potential triggers and conduct a comprehensive diagnosis of the company as in Gomez et al. (2012). We elaborate on the analysis starting from a macro process analysis. This technique is carried out to prioritize criticality. The process is separated into 2 levels, this representation is shown in Figures 1 and 2.

ROW #	PERCENTAGE	CRITERIA \ MACROPROCESS	COMERCIAL ADMINISTRATION	MANAGEMENT	SUPPLY	PRODUCTION AND BOTTLING	DISTRIBUTION	QUALITY	LOGISTICS	OCCUPATIONAL HYGIENE AND SAFETY	MAINTENANCE OF MACHINES AND EQUIPMENT	ACCOUNTING AND FINANCIAL MANAGEMENT	HUMAN RESOURCES	INFORMATION SYSTEMS	METROLOGY	TREASURY
		COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	15%	SALES LEVEL	9	1	3	9	3	3			1	1		1		3
2	10%	INVENTORY	1		9	9	3		3						1	
3	10%	PRODUCTION COSTS IMPACT			1	1	3				3	1			1	3
4	10%	SERVICE TIME IMPACT	1		3	3					3			3	1	3
5	10%	PRODUCT QUALITY						9			3				3	
6	5%	ACCIDENT RATES		1						9			1			
7	10%	UNCOMPLETE ORDERS	3		3	9		3			3	1	3	3		3
8	15%	PLANT STOPS								3	9		3		3	
9	5%	NFORMATION SYSTEM OPERATIVIT												9		
10	10%	PRODUCT REJECTIONS						9							3	1
	100%	AVERAGE	1.85	0.2	2.05	3.55	1.05	2.55	0.3	0.9	2.7	0.35	0.8	1.2	1.35	1.45
	20.3	LEVEL OF IMPORTANCE	9%	1%	10%	17%	5%	13%	1%	4%	13%	2%	4%	6%	7%	7%

Figure 1. Macro Process Matrix

First Level Analysis: The macro process, represented in Figure 1 shows the prioritization matrix where a greater percentage of decisions is given to the criteria that affect the strategic company planning. Scoring uses values represented as 1, 3, and 9. The process of identifying areas involves evaluating criteria, such as their impact on customer satisfaction, operational efficiency, feasibility, cost-effectiveness, and alignment with organizational goals. Improvement opportunities are then evaluated against these criteria by employing a rating scale. Total scores for each opportunity are derived by multiplying ratings with criterion weights. Subsequently, the prioritization matrix is visually represented to pinpoint top priorities. Action plans for implementation are developed based on these prioritized criteria.

Second Level Analysis: The second level of processes outlines responsibilities and activities. The most critical process stage within the company is graphed, chosen through the prioritization matrix as is depicted in Figure 2. The prioritization matrix assigns decision percentages based on criteria that directly impact the strategic objectives of logistics management. The need to carry out a study and find the causes of the problem in the production processes is evident in the highlighted items. Results reveal bottling process carries higher importance.

ROW #	PERCENTAGE	CRITERIA \ PROCESS	PRODUCTION	INVENTORY	PRODUCT FILLING
		COLUMN #	1	2	3
1	20%	PLANIFICATION AND DEMAND FORECAST	9	3	9
2	5%	ORGANIZATION AND ORDER RECEPTION	9		
3	5%	HUMAN RESOURCE PROBLEMS	3	3	
4	5%	PLANT FAILURES	9		
5	5%	PROCESS STANDARIZATION	9		
6	5%	CLEANING AND MAINTENANCE	3	9	3
7	10%	STORAGING		1	9
8	15%	LACK OF RAW MATERIAL			9
9	15%	STRESS CONDITIONS IN WORK			9
10	15%	PRODUCT QUALITY			9
	100%	AVERAGE	3.45	1.3	6.9
	11.65	LEVEL OF IMPORTANCE	30%	11%	59%

Figure 2: Priorization matrix

Plant personnel familiarity with the processes and the inherent deficiencies has enabled the identification and articulation of key objectives essential for effective measurement and evaluation. Figure 4 represents the values defined by the process experts with a minimum threshold highlighted exemplifying 5 months.

A. Key Performance Indicators

Plant personnel familiarity with the processes and the inherent deficiencies has enabled the identification and articulation of key objectives essential for effective measurement and evaluation. Figure 3 represents the values defined by the process experts with a minimum threshold highlighted exemplifying 5 months.

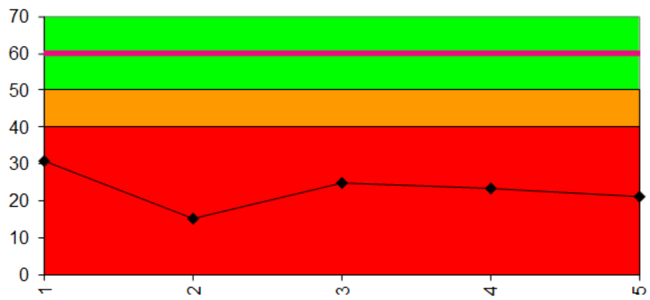

Figure 3: KPIs

The utilization indicator provides insights into the availability of finished product warehouse capacity. This evidences the resource underutilization, often remaining vacant for extended periods. This under-utilization is corroborated by the warehouse utilization indicators, which reveal instances where incoming orders cannot be met due to the absence of sufficient finished products acting as a safety stock. Consequently, there is an increased necessity to manufacture additional quantities across various product presentations. The prevailing situation within the plant underscores one of the key factors contributing to the inadequate fulfillment of orders from major clients.

B. Problem Prioritization

Table I shows how problems affect the economic aspect due to the number of occurrences in each of the indicator cards. These problems will be classified according to their impact on profits. During the analytical scrutiny under-taken, a comprehensive exploration of the underlying factors impeding the operation of the process is conducted. Initially, a macroscopic assessment (Level 1) was utilized to delineate two primary avenues for addressing the prevailing challenges within the company. After this preliminary evaluation, a more granular examination (Level 2) is undertaken, revealing two distinct categories: suboptimal production planning and deficiencies in the operational efficacy of the production process. These delineations are visually explicated in the relational diagram. The deficiencies in production planning manifest in erratic order creation, exacerbated by recurrent stock shortages requiring overtime (OT). Despite the infusion of additional labor hours, persistent impediments such as inventory deficits, scarcities in raw materials, and operational malfunctions with critical tools and machinery (ex. Silicone gun or packer belt) impede order fulfillment. Consequently, the excessive reliance on overtime engenders personnel fatigue, precipitating a decline in both productivity and product quality. Furthermore, the underutilization of warehouse resources, averaging 30%, underscores missed opportunities to maintain a safety stock buffer to accommodate larger orders. Within the purview of the production process, inefficiencies are underscored by the inadequate yield of treated water designated for filling, evinced by the discrepancy between the projected allocation and the actual supply from production lines. This discordance precipitates significant wastage of this critical resource. Moreover, the final packer waste represents the volume of discarded packages across various product presentations. It underscores several contributory factors including substandard handling practices, time constraints, and a dearth of specialized expertise. Insufficient quality control measures preceding the final processing stage exacerbate the issue, resulting in defective products and substantial waste. The insights gleaned from this comprehensive analysis are succinctly encapsulated in the Ishikawa diagram (refer to Figure 4), which provides a sampled visualization of the interconnected factors contributing to the identified challenges.

TABLE I
PROBLEM LIST

N	PROBLEM	COST	CUMULATIVE COST	%	CUMULATIVE. %
1	LOW EFFECTIVENESS IN THE PRODUCTIVE PROCESS	257486.21	257486.21	29%	29%
2	ABRUPT TENDENCIES IN THE REQUEST CADENCY VARIANCE	228564.876	186051.0858	26%	55%
3	FINAL PACKAGING DECREASE	171141.225	657192.3111	19%	75%
4	WATER TREATMENT DECREASE	114207.053	71399.3645	13%	88%
5	UNATTENDED STORAGE REQUESTS	65611481	837010.8455	7%	95%
6	HIGH EXTRA HOUR USAGE	41888.1996	878899.0452	5%	100%
		878899.045		100%	

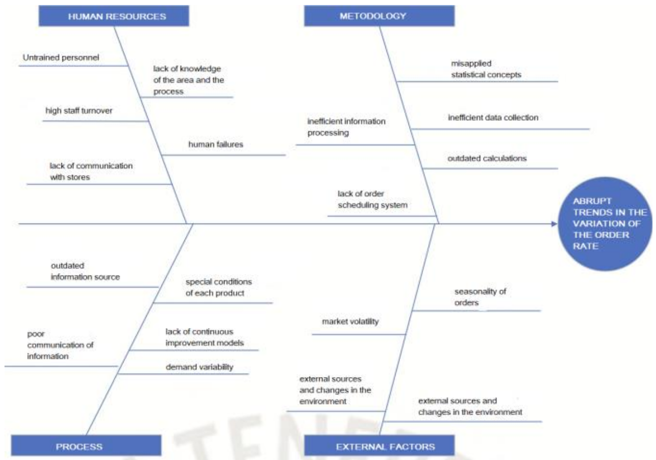

Figure 4: Ishikawa diagram

C. Main Factors:

The primary objective of the prioritization matrix is to systematically prioritize solutions that will yield the most effective outcomes upon implementation. This prioritization process involves leveraging data from the previous table, with additional insights provided by the production manager. Root causes will be systematically numbered for clarity and ease of reference. Subsequently, each cause will be subjected to predetermined criteria, assigning a score of 1, 2, or 3 based on its significance and impact. These scores will then be multiplied by the corresponding weighting factor, reflecting the relative importance of each cause. Finally, the solutions will be organized in descending order of priority, facilitating a clear visualization of the critical path forward.

Following the analysis conducted using the prioritization matrix, the prioritization of root causes No. 1, 2, and 3 has been determined, accompanied by the methodologies ear-marked for implementation. This strategic alignment enables targeted interventions to address critical issues efficiently.

TABLE II
FACTIS MATRIX

N	CRITERIA	F	A	C	T	I	S	TOTAL
1	DATA ANALYTICS (ISIM)	EASY 3	SOME 2	LOW 1	MID 2	MID 2	HIGH 3	47
2	TAKT TIME	HARD 2	SOME 2	MID 2	LONG 1	MID 2	MID 2	37
3	PRODUCTION SCHEDULING	HARD 2	YES 1	LOW 1	MID 2	LOW 3	LOW 1	40

TABLE III
FACTIS RESULTS

ROOT CAUSE	TOTAL	METODOLOGY
LACK OF PRODUCTION PLANNING	47	DATA ANALYTICS (ISIM)
EXCESIVE USAGE OF EXTRA HOURS	40	PRODUCTION SCHEDULING
LACK OF WORK RHYTHM ESTABLISHMENT	37	TAKT TIME

III. IMPLEMENTATION

A. Modeling:

Two commonly used in literature models are Arima, Prophet and LSTM. We performed a modeling, and which is out of the scope of the article. Models outputted similar results in terms of performance granting the Arima model (260), the Prophet model (276), and the LSTM model (228) percentage of error in terms of package numbers. It is observed that there is slight better performance between the Arima model and the LSTM model. Therefore, it is worth highlighting that among the differences between both models, the LSTM model is preferred due to its advantage and ease of automation, as well as its ability to handle a higher number of observations in the future. It also handles peaks and temporal periods. The LSTM model is selected for the implementation of the demand planner.

B. Planner:

The diagnosed issue of inadequate production planning looms large. Current workflow is rudimentary, involving the mere noting down of required orders followed by their production. Operating without prior planning based on historical data and the establishment of safety stocks renders the company incapable of meeting customer demands, often resulting in abrupt disruptions. Consequently, even with round-the-clock operations at full capacity across three shifts, the company finds it impossible to fulfill requested orders. Moreover, the lack of structured organization in this planning process only serves to exacerbate the problem further.

The proposed model considers the workflow, which consists of historical observations, to be fed with each of the order requests. This information will be used to feed the model and make subsequent predictions, which will be displayed through the graphical interface. As known, inputs such as planned orders, forecasted demand, current inventory, production limits, production policy (Lead Time), product characteristics (input requirements), and reorder point for inputs will be considered as in Fourie et al. (2018)

The solution proposed for the company under study will consist of an HTML-based MPS, where predictions will be developed by the LSTM model, written in Python, and all interactions will be done through JavaScript. Calculations related to the planner calendar, production calculations, waste, Takt Time calculation, database recording, and information loading will be managed through PHP. The configuration regarding input requirements per item will be fed from the database. The web application will use an SQLite database and the IIS web server.

The web solution will consist of 3 windows. The main screen, which we will call the production planner, will have a bar that shows access to navigate between interfaces, which is retractable to make better use of the screen space.

Definitions:

$$
\begin{aligned}
\Pi &: \text{Production} \\
\Sigma &: \text{Stock} \\
\Delta &: \text{Demanded Supply} \\
\Sigma_\kappa &: \text{Stock}_\kappa \\
\Gamma &: \text{Constant Production} \\
\Sigma_{\text{ld}} &: \text{Sold} \\
\Upsilon &: \text{Initial Investment} \\
\Lambda &: \text{Merma product terminado} \\
\Phi &: \text{Final Investment} \\
\Upsilon_{\text{initial}} &: \text{Investment Initial} \\
\Theta_1, \Theta_2, \Theta_3 &: \text{Turnover 1, 2, 3} \\
\Upsilon_{\text{F}} &: \text{Inventory Final} \\
\Sigma_{\text{S}} &: \text{Stock Seguridad}
\end{aligned}
$$

$$
\begin{aligned}
\Pi + \Sigma_\kappa[t-1] &= \Delta + \Sigma[t] \\
\Gamma[t] - \Sigma_{\text{ld}} - \Upsilon - \Lambda[t] &= \Phi = \Upsilon_{\text{initial}}[t+1] \\
\Theta_1[t] + \Theta_2[t] + \Theta_3[t] &= \Gamma[t] \\
\Upsilon_{\text{F}}[t] &\geq \Sigma_{\text{S}}[t]
\end{aligned}
$$

The requested column will be editable by the user, as well as the initial inventory and each of the shifts for the quantity to be produced. At the bottom of the" quantity to produce" row, each quantity to be produced in the respective shifts will be found. Finally, the finished product waste will allow the registration of waste that occurs in production when the finished product is obtained (inadequate transport, bottle depressurization, deformations due to packaging, among others). The scheduler is shown for the third week of January 2020. A similar structure for the forecast model can be seen in Romeijnders et al. (2012).

The last row of the scheduling scheme will contain the safety stock, for which a visual notifier has been implemented. In case the safety stock is low, it will be activated with a red hue. The stock will follow an inventory system that will maintain the calculated level and notify us when we need to replenish the order according to the demand volume. It is worth noting that this will be an inventory of finished products according to their use and time, of safety stock, to avoid order non-compliance caused by demand spikes. To find this parameter, it is necessary to calculate the following variables: We will start with the calculation of the safety stock SS = Kσ′, which will be comprised of the value k of the service level, which will be set at 90%, giving an equivalent K of 1.28. We will proceed with the value of prime sigma σ′, for which the formula.

$$
\sigma'[d] \quad = \quad \sqrt{LT \times \sigma_{\text{demand}} + \text{Demand}_{\text{Media}}^2 \times \sigma_{\text{LT}}^2}
$$

will be applied. The parameters will be obtained from the statistical studies previously conducted and the order requests. The day the order is received and the date the order is required will be taken into consideration. The calculation of the Lead Time considers the adjustments of the orders, which notably have reduced Lead Times.

$$
\begin{aligned}
\text{SS} &= K \times \sigma' \\
\sigma'[d] &= \sqrt{LT \times \sigma_{\text{demand}} + \text{Demand}_{\text{Media}}^2 \times \sigma_{\text{LT}}}
\end{aligned}
$$

After performing these calculations, which can be edited in the configuration tab, the following table is observed where the parameters required for calculating the safety stock were collected. As a result, it was determined that for a 90% service level, 2161 packages of Bells 2.5 L should be in stock, thus providing prevention against stockouts. A similar analysis is conducted for the rest of the products. It is noted in Excel that, if all safety stocks are maintained, they would require the use of 106 pallets, which translates to 255.54 m2 of space in the finished product warehouses. These calculated data will be recorded in the security stock configuration tab, allowing the scheduler to consider these values when displaying the scheme.

The present Takt Time will be calculated using the formula where the available time, corresponding to (79.69%) 80% of the total time of an 8-hour shift in minutes, will be divided by the units per shift to be fulfilled. This will provide the corresponding indicator for each of the processes. This is thanks to the analysis and observation of different production shifts throughout the elaboration of this thesis. Each of the Takt Times corresponding to the shifts will be displayed through a tooltip.

The second interface will consist of the viewer for supplies and raw materials, which will provide a visually pleasant interface, maintaining vigilance over the safety stock. This will allow the prevention of stockouts as it will provide real-time information on supplies, enabling proper production planning.

The third interface will be constituted by the registration and visualization of the different materials/supplies required for the production of each of the company's articles. This interface consists of a table that displays the different names of the items required for production in the first row, which have been previously configured in the database. In addition, the replenishment point of each item has been specified. The third row will allow observation of the different quantities currently held in the plant's warehouses; finally, in the fourth row, numeric input boxes are observed to update each of the article and supply inventories in the plant.

A fragment of the calculations performed to find the reorder point for production inputs is observed, in which the lead time, which is in weeks, was previously converted. These values were collected from various records provided by the logistics area. The safety stock and reorder point were calculated, resulting in the following values. A 90% service level was used, and this analysis and calculation were performed for the rest of the products.

IV. SYSTEM UI

This model will comprehensively incorporate the workflow, leveraging historical observations continuously augmented with each new order received. These historical data points form the backbone of the model and serve as the basis for subsequent predictions. The graphical interface will visually represent how this data feeds into the model's algorithms. An infographic showing the proposed workflow and use of the interface is shown in Figure 6.

The proposed solution for the company under study will entail the development of a ro- bust Manufacturing Planning System (MPS) primarily built using HTML. The predictive capabilities will be facilitated by an LSTM (Long Short-Term Memory) model implemented in Python. All user interactions within the system will be orchestrated through JavaScript for seamless functionality. Key functionalities such as planning calendar management, production calculations, waste reduction, Takt Time derivation, database integration, and data retrieval will be efficiently managed using PHP. This comprehensive framework forms the reference configuration for the solution, ensuring a cohesive and efficient system tailored to the company's specific needs.

Figure 6: MPS Scheduler UI

(1) Planner Scheme: A main interface that allows planning and editing parameters such as (initial inventory, requested, produced) for the purpose of calculation. (2) Save: Used to store the planner records in the database in order to be able to view the changes later. (3)Select Products: Used to select the product to be planned. (4) Select Week: Used to select the week to be planned. (5) Visualization interface: Allows you to view the different values of the planning scheme. (6) Closing inventory: After the query, it displays the closing inventory of the previous week, with which the planner will start the week

V. TECHNICAL EVALUATION

A. Technical evaluation for the demand planner

The technical analysis resulting from the implementation of the presented improvement within the production area will be conducted with a specific focus on the enhancements outlined in the previous section. It is important to note that the comparative analysis will span from the last month of 2019 to the first month of 2020 for B brand products, following the implementation of the improvements. This time frame was chosen due to its alignment with business conditions and similarity for accurate assessment. The proposed demand planned, and the benefits are presented in Figure IV.

The reduction in the use of overtime due to correct production scheduling. Since the use of overtime entails higher man-hour costs for production personnel, which is a mandatory factor by law, it makes it counterproductive for the company's profits.

The present implementation of the MPS (Master Production Schedule) allows for correct planning of orders, thus reducing the number of overtime hours required to complete the requested orders. This will be achieved by recording the number of packages requested in the demand scheduler. Various calculations will be made, and production personnel will be offered the ability to plan production for the different days of the week to meet the requested production requirements.

Excessive use of overtime is an identified problem, according to the Ministry of Labor2, the surcharge factors are included under VII. There is a decrease in the use of the first 2 overtime hours of 61%, 63% for the use of up to the third and 100% in use greater than 3 extra hours. In short, a 75% reduction in the use of overtime. Furthermore, it is verified that by making a monetary comparison the costs are reduced by up to 80%, thus demonstrating a significant improvement in the use of human resources.

Reduction of misuse of resources through the correct establishment of work shifts. It is evident that the staff, after long workdays and as the days of the week go by, lose their efficiency in their work, as can be seen in the present study (Brunies, 2001), author belonging to the PMI (Project Management Institute). In which it is verified that working more than 50 hours per week affects work performance, It should be noted that because the process in the company is mostly manual, as is known from the explanation of the production system. This is translated into poor use of resources, especially those that require management by production operators.

The implementation of the work rhythm made it possible to reduce the need for personnel from other areas to perform functions on the production line; this allowed,
according to the productive load, to accelerate the number of packages thrown out by the line or to reduce this amount. It is the production staff who performs the functions, thus avoiding the factor of inexperience of external personnel in the area which can cause problems. Furthermore, when the number of packets on the line is low, it allows the correct use of resources; that is, redirect said production operator or operators to perform tasks that may be required or pending.

B. *Technical evaluation for establishing the inventory system.*

Reduction of order non-compliance due to the establishment of safety stocks and order point. After the personal factor, the shortage of inputs is the second cause of order fulfillment, the correct establishment of the order point for productive inputs allowed production stoppages to be avoided. The application of safety stock of finished products allowed the reduction of noncompliance with orders. In the last month of 2019, a service level of 83% was contemplated. After the improvement, it is intended to contemplate a service level of 90%. Given this, it is intended to avoid the penalties imposed by Peruvian supermarkets for non-compliance with these. These penalties are expensive, and They constitute an important expenditure of money. A comparative table was made to compare the pre and post-improvement where it was observed and concluded that the proposal made managed to reduce by approximately 41%, in general, the penalties that have been imposed by the company caused by non-compliance/compliance. late delivery of products for every 1000 packages requested, it is worth highlighting these costs already contemplate transportation costs and opportunity costs by Peruvian supermarkets, the comparison is made in the sanction applied by the client, thus generating an economic benefit for the company after the implementation of the solution Calculation are shown in Section VI.

VI. CONCLUSION AND DISCUSSION

We aim to improve the production planning process which involves mitigating the non-compliance with orders. First, the use of the MPS production planner integrates various components such as a forecast model, inventory control, and production management to streamline the production process. Second, the lack of proper planning, inadequate safety stocks, and poorly defined order points contribute to rushed production, skipped controls, and ultimately, order non-fulfillment. Correct planning, facilitated by MPS implementation, leads to a significant reduction in penalties (41.48%). The implementation of an inventory control and order point paired with the above-presented tool helps prevent shortages of productive resources, ensuring smooth production flow while the use of safety stocks mitigates abrupt losses caused by fluctuations in demand for different products. Third, the inclusion of the Takt Time allowed a granular production cadence control, facilitating the achievement of production goals per shift.

This results in substantial improvements such as an 80.22% reduction in overtime usage, a 45.93% decrease in resource mismanagement, and a 51.47% decrease in improvisation during production. Finally, The use of an LSTM model avoids the inadequacy of existing demand projection methods. The model led to better demand projections by accommodating seasonalities and non-linear trends effectively.

Economic indicators demonstrate the technical and economic viability of the proposals, with an additional average monthly profit of 20.64KPEN observed for the product under study. In summary, the thesis proposes a holistic approach that integrates various methodologies, including MPS, inventory control, Takt Time calculation, and data analytics, to enhance production planning and mitigate order non-compliance issues.

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